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ENVIRONMENTAL RESEARCH PROGRAM

RESEARCH NEEDS 1988/89

Ontario
Ministry of the Environment

Hon. Jim Bradley
Minister

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1988/89

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Research Management Office
Policy and Planning Branch

Environment
Ontario

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Introduction

This report presents a summary of the 1988-1989 scientific research priorities of the Ontario Ministry of the Environment. The document has two purposes: to assist researchers in submitting requests for financial assistance in support of environmental research, and to ensure that designated research resources are appropriately allocated. The report includes a list of current research issues and needs, classified into five research areas: Air Quality, Water Quality, Liquid and Solid Wastes, Analytical Method Development and Socio-Economic Research. A summary table is presented at the front of each research area and related research issues in other areas are indicated in footnotes. A copy of the application for research funding, 'Form 02' follows as an attachment. Additional forms can be obtained from the Research Management Office.

Two booklets: 'Guidelines for Submission of Research Proposals' (November, 1987) and 'Research Management Process' (April, 1987) are now available from the Research Management Office to assist the applicant. The two 1988 deadlines for submitting proposals are January 15 and June 15; however researchers are encouraged to submit proposals in advance of the deadlines to ensure sufficient review time. The original and five copies of the research proposal should accompany the completed Form 02 and be sent to:

Research Management Office
Policy and Planning Branch
Ontario Ministry of the Environment
135 St. Clair Ave. West
Toronto, Ontario
M4V 1P5
Tel. # (416) 323-4574

Once received by the Ministry, proposals are evaluated on their scientific merit, on their relevance to Ministry research needs and priorities, and on funding availability. This procedure ensures that research and research expenditures are consistent with MOE policies, goals and objectives. The needs listed are not intended to limit the submission of new ideas for research; innovative proposals for work not included in the identified research needs will also be considered.

Grant or contract awards are subject to a number of conditions which are detailed in a grant letter of agreement or a formal contract; and which include the following:

- research is managed by the appropriate MOE Branches, Regions, Boards and Advisory Committees, through a Project Liaison Officer, and is administered by the Research Management Office;

- research performance is evaluated on the basis of written progress reports submitted by the investigator every six months and approval for the second or third year of a multi-year project is contingent upon a satisfactory progress report and a written recommendation by the Liaison Officer;

- grant recipients are required to provide a statement of expenditures at the end of each fiscal year (March 31) to the MOE Liaison Officer and the Research Management Office;

- research results are to be detailed in a final, Ministry approved final report in a reasonable timeframe following completion of the project; and

- implementation of research findings is strongly encouraged.

Following technical review of the proposals, the Research Advisory Committee meets in April and September to make recommendations on the funding of the proposals. Applicants will generally be notified of the outcome within two to five weeks of these meetings. An annual research inventory of ongoing projects will be made available to the public, and investigators will be required to present their progress and findings at the annual Technology Transfer Conference.

Ontario is already well represented in the world arena of environmental research in many of the areas identified in this report. By addressing the needs detailed here, investigators are encouraged to complement and further advance research to continue to strengthen Ontario's presence in applied state-of-the-art environmental research.

SUMMARY OF AIR QUALITY RESEARCH ISSUES

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
AIR QUALITY RESEARCH			
Contaminant Effects/ Toxicology/ Fates	AR01 Determination of the effects of pollution on human beings	5	SE01/103
	AR02 Determination of the impact of pollution on eco-systems	6	WA24/ 48 SE01/103
	AR03 Use of phytotoxicology in identifying and quantifying the effects of air pollutants	7	WA16/ 40 SE01/103
Atmospheric Processes (Including Source-Receptor Links)	AR04 Understanding of atmospheric dispersion of air emissions	8	WA11/ 35 WA22/ 46 LS03/ 66 SE02/105 SE06/109
	AR05 Development of improved emergency response capability	9	
	AR06 Understanding of the physical/ chemical processes involved in the phenomena of acid rain and long-range transport	10	AN16/ 97 SE06/109
Risk Management/ Criteria Development	AR07 Development of better risk assessment capability	11	AN18/ 99 SE03/106
Sources/ Inventories	AR08 Identification and quantification of industrial/ commercial emissions	12	LS03/ 66 AN17/ 98 SE02/105

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
Sources/ Inventories (continued)	AR09 Identification and quantification of stationary domestic sources	13	
	AR10 Identification and quantification of mobile sources	14	SE02/105
Instrument Development and Application	AR11 Improvement in monitoring capability for air pollutants	15	WA08/ 32 LS03/ 66 LS13/ 76 AN17/ 98
Control and Remedial Technology	AR12 Assessment of new control technology and devices	16	SE02/105 SE04/107
	AR13 Development of new control processes	17	LS02/ 65 LS03/ 66 SE02/105
	AR14 Development of remedial measures due to air pollution effects	18	SE02/105

AIR QUALITY RESEARCH: CONTAMINANT EFFECTS/TOXICOLOGY/FATES

ISSUE: AR01

Determination of the effects of pollution on human beings.

Type of Research Needed:*

- Evaluation of acute and chronic effects of pollutants (single or multiple) on human health.
- Determination of the effects of non-ionizing radiation on humans.
- Determination of the relationship of noise and vibration levels to quality of life.
- Determination of the relationship between monitoring data, human health and various specific air pollution problems.

***See Also:**
Socio-Economic Research: Environmental Damages and Benefits - **SE01**

AIR QUALITY RESEARCH: CONTAMINANT EFFECTS/TOXICOLOGY/FATES

ISSUE: AR02

Determination of the impact of pollution on eco-systems.

Type of Research Needed:*

- Studies of the accumulation and environmental pathways of toxic substances with particular reference to the Great Lakes Basin.
- Investigation of impact of S,N acids from the atmosphere due to Long Range Transport of Air Pollutants (LRTAP).
- Determination of which air contaminants are having direct or indirect impact on animal life.
- Development/screening of invertebrates for biological-indicators of environmental contaminants.

***See Also:**

Water Research:	Impact of Pollutant Discharges on Aquatic Systems - **WA24**
Socio-Economic Research:	Environmental Damages and Benefits - **SE01**

AIR QUALITY RESEARCH: CONTAMINANT EFFECTS/TOXICOLOGY/FATES

ISSUE: AR03

Use of phytotoxicology in identifying and quantifying the effects of air pollutants.

Type of Research Needed:*

- Determination of the physiological pathways by which pollutants enter plants.
- Study of the interaction between plant diseases and various pollutants to determine the important parameters which affect the response of the plant.
- Systematic sampling of vegetation to determine the background concentrations of organic and inorganic compounds.
- Examination of the concept of pollutant flux into crop and forest canopies and to determine how agrometeorological factors affect pollutant uptake by vegetation.
- Assessment of the effect of accumulation of various pollutants on vegetation.
- Determination of the optimum, critical, and toxic concentration of various elements in the soil in forms available to plant (especially forest species) roots.
- Development of vegetation monitors for environmental contaminants of interest.

***See Also:**

Water Quality Research:	Contaminant Fate and Transport Processes in Aquatic Systems - **WA16**
Socio-Economic Research:	Environmental Damages and Benefits - **SE01**

AIR QUALITY RESEARCH: ATMOSPHERIC PROCESSES (including Source-Receptor Links)

ISSUE: AR04

Understanding of atmospheric dispersion of air emissions.

Type of Research Needed:*

- Modelling and field studies of dispersion from non-standard sources (e.g. mine tailings, fugitive emissions).
- Physical modelling of stable atmospheric dispersion.
- Modelling of concentration fluctuations; e.g. odours.
- Study of the quantification of boundary layer turbulence.
- Development of meteorological instruments for boundary layer turbulence characterization.
- Study of building wake dispersion.

***See Also:**

Water Quality Research:	Managing Non-point Sources of Pollution - **WA11**
Water Quality Research:	Contaminant Fate and Transport Processes in Aquatic Systems - **WA22**
Liquid & Solid Waste Research:	Waste Handling - **LS03**
Socio-Economic Research:	Costs of Controls and Mitigation - **SE02**
	Environ-Economic Modelling - **SE06**

AIR QUALITY RESEARCH: ATMOSPHERIC PROCESSES (including Source-Receptor Links)

ISSUE: AR05

Development of improved emergency response capability.

Type of Research Needed:

- Improvement of the methods for calculating toxic compound concentrations downwind of emergency sites.

AIR QUALITY RESEARCH: ATMOSPHERIC PROCESSES (including Source-Receptor Links)

ISSUE: AR06

Understanding of the physical/chemical processes involved in the phenomena of acid rain and long-range transport.

Type of Research Needed:*

- Studies of the atmospheric deposition and transformation of substances involved in the acid rain problem and other pollutant studies.
- Refinement of long-range and meso-scale atmospheric transport modelling including physical modelling of heavy gas dispersion in a complex urban setting.
- Determination of the deposition mechanisms of airborne compounds.
- Parameterization of cumulus clouds in long-range transport models.
- Development and evaluation of atmospheric deposition monitoring equipment.
- Derivation of new methods to quantify air quality and long-range transport of pollutants in Ontario.
- Development of techniques suitable for routine, monitoring in remote areas of Ontario.

***See Also:**

Analytical Method Development:	Air and Water Analysis - **AN16**
Socio Economic Research:	Enviro-Economic Modelling - **SE06**

AIR QUALITY RESEARCH: RISK MANAGEMENT/CRITERIA DEVELOPMENT

ISSUE: ARO7

Development of better risk assessment capability.

Type of Research Needed:*

- Development of better risk assessment techniques for air quality protection.
- Determination of the risk due to specific airborne contaminants.
- Provision of sufficient information to establish exposure standards (including socio-economic studies).

***See Also:**

Analytical Method Development:	Biological Analysis - **AN18**
Socio-Economic Research:	Evaluation Tools and Applications - **SE03**

AIR QUALITY RESEARCH: SOURCES/INVENTORIES

ISSUE: AR08

Identification and quantification of industrial/commercial emissions.

Type of Research Needed:*

- Identification and quantification of emissions (e.g. source measurements and inventory emissions methodology development) of PAHs, Dioxins, PCBs, pesticides, trace metals, etc. from various area and point sources.

- Development of inexpensive stack samplers which can be quickly put in place.

***See Also**

Liquid & Solid Waste Research:	Waste Handling - LS03
Analytical Method Development:	Air Analysis - AN17
Socio-Economic Research:	Costs of Controls and Mitigation - SE02

AIR QUALITY RESEARCH: SOURCES/INVENTORIES

ISSUE: AR09

Identification and quantification of stationary domestic sources.

Type of Research Needed:

- Determination of the quality and significance of residential wood burning on air and precipitation quality.

AIR QUALITY RESEARCH: SOURCES/INVENTORIES

ISSUE: AR10

Identification and quantification of mobile sources.

Type of Research Needed:*

- Identification and quantification of individual organic compounds and trace metals in the exhaust of internal combustion engines.

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*See Also
Socio-Economic Research: Costs of Controls and Mitigation - SE02

AIR QUALITY RESEARCH: INSTRUMENT DEVELOPMENT AND APPLICATION

ISSUE: AR11

Improvement in monitoring capability for air pollutants.

Type of Research Needed:*

- Development of monitors for toxic substances.
- Development of sampling methods for semi-volatile toxics e.g. PAH's PCDD's etc.
- Study of high resolution and multidimensional (high resolution) GC and development of a data base for mobile monitoring of organic compounds.
- Determination of the monitoring capabilities required to adequately assess human exposure to air pollutants.
- Development of measurement methods for arsenic and other volatile metals and organometallics.
- Development of calibration standards for trace organic compounds and procedures for field calibration of complex mixtures.
- Study of the ion chemistry of CI/MS and CI/MS/MS and development of the data base for organic compounds specific to APCI source (required for application to TAGAs).
- Study of high resolution and multidimensional (high resolution) GC in connection with EI-MS and FTIR and development and expansion of the appropriate data base for real time mobile monitoring.
- Development of monitoring methodologies and equipment for odorous compounds.
- Development of sampling techniques and protocols for air pollutants with appropriate instrumentation and integration with appropriate analyzers.
- Development of monitors (both continuous and remote sensing) for common pollutants.
- Development of portable reliable field monitors and samplers for specific contaminants.

***See Also**

Water Quality Research:	Municipal Wastewater Treatment - WA05 - WA08
Liquid and Solid Waste Research:	Waste Handling - LS03
Liquid and Solid Waste Research:	Landfill Technology - LS13
Analytical Method Development:	Air Analysis - AN17

AIR QUALITY RESEARCH: CONTROL AND REMEDIAL TECHNOLOGY

ISSUE: AR12

Assessment of new control technology and devices.

Type of Research Needed:*

- Development of accurate, unbiased assessment techniques for new control technologies for contaminants of major concern in Ontario.

***See Also**

Socio-Economic Research:	Costs of Controls and Mitigation - **SE02**
Socio-Economic Research:	Environmental Protection Industry - **SE04**

AIR QUALITY RESEARCH: CONTROL AND REMEDIAL TECHNOLOGY

ISSUE: AR13

Development of new control processes.

Type of Research Needed:*

- Development of disposal techniques for combustion residues from industrial.
- Development of new control processes to control air emissions.

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*See Also

Liquid & Solid Waste Research:	Waste Handling - LS02 - LS03
Socio-Economic Research:	Costs of Controls and Mitigation - SE02

AIR QUALITY RESEARCH: CONTROL AND REMEDIAL TECHNOLOGY

ISSUE: AR14

Development of remedial measures due to air pollution effects.

Type of Research Needed:*

- Development of alternatives to removal of contaminated soil.
- Development of cultivars of plants which will be less sensitive to air pollutants such as ozone.
- Development of techniques for revegetating alkaline and/or saline soil.

***See Also**
Socio-Economic Research: Costs of Controls and Mitigation - SE02

SUMMARY OF WATER QUALITY RESEARCH ISSUES

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
WATER QUALITY RESEARCH			
Industrial Wastewater Treatment	WA01 Efficiencies of selected conventional and advanced wastewater treatment systems currently used in the Ontario pulp and paper, steel and petroleum/ petrochemical industry	25	AN12/ 93 AN18/ 99 SE02/105
	WA02 Efficiencies of selected conventional and advanced wastewater treatment systems used by industrial concerns discharging wastes to municipal sewer systems including: - organics chemicals sector - printing and publishing sector - electrical and mechanical equipment - waste recycling sector (including solvent, drum, oil, battery and metal recyclers) - food and kindred products sector - manufacturing sector - services sector	26	AN12/ 93 SE02/105
	WA03 Hazardous chemicals in sewer systems	27	
	WA04 Treatment of hazardous wastes in sewer systems	28	SE02/105

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
Industrial Wastewater Treatment (continued)	WA05 Emerging technologies for industrial process changes to reduce contaminant loadings to waste streams	29	AR11/ 15 LS02/ 65 SE02/105 SE03/106
Municipal Wastewater Treatment	WA06 Prediction of fate and removability of hazardous compounds in municipal water pollution control plants	30	AN12/ 93
	WA07 Innovative sewage treatment process research	31	
	WA08 Development of compliance and monitoring tools	32	AR11/ 15 AN09/ 90 SE03/106
Managing Non-Point Sources of Pollution	WA09 Natural occurrence of some organic and inorganic contaminants (eg. heavy metals, phenols, fluorides, radioactive materials) in surface and groundwaters	33	AN16/ 97
	WA10 The impact of agricultural tile drainage on receiving watercourses	34	
	WA11 Agricultural nutrient sources and transport	35	AR04/ 8
	WA12 Pesticide residues in tributaries and their impact on the inland water system and Great Lake connecting channels	36	

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
Managing Non-Point Sources of Pollution (continued)	WA13 Quantifying uncertainty in nutrient/contaminant loadings in-stream and its projected impact on the Great Lakes	37	
	WA14 Remedial measures to minimize the impact of agricultural practices on water quality	38	
	WA15 Characterization of the hazardous contaminants in combined sewage overflows (CSO's) and stormwater runoffs (SWR's) and development of optimal control options	39	
Contaminant Fate and Transport Processes in Aquatic Systems	WA16 Persistence, migration and breakdown processes of select hazardous contaminants in soil and groundwater	40	AR03/ 7 LS15/ 78 AN16/ 97
	WA17 Prediction of currents from wind data at locations where no current meters have been operated	41	
	WA18 Development of a numerical/mathematical model to predict the extent and water quality of a river plume where it merges in a lake	42	

RESEARCH CATEGORY		ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
Contaminant Fate and Transport Processes in Aquatic Systems (continued)	WA19	Development of a numerical/mathematical model to predict the hydrodynamics of the whole lake and then focus on a local area for better resolution	43	
	WA20	Defining the fate and transport of bacteria, organic and inorganic compounds in the nearshore Great Lakes environment by incorporating the effects of physical processes	44	
	WA21	Fate and pathways of in-stream pollutants associated with suspended sediments	45	
	WA22	Model development for mine tailing discharge assimilation	46	AR04/ 8
	WA23	Distribution and behaviour of mercury in aquatic systems	47	
Impacts of Pollutant Discharges on Aquatic Systems	WA24	Biological response to contamination from industrial and municipal discharges	48	AR02/ 6 AN12/ 93 AN18/ 99 SE01/103

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
Impacts of Pollutant Discharges on Aquatic Systems (continued)	WA25 Aquatic macrophyte and algal responses to anthropogenic and other controlling factors and the role of aquatic plants in nutrient and contaminant cycling in the aquatic environment	50	
	WA26 Statistical significance in contaminant sampling	51	SE03/106
	WA27 The impacts of in-place pollutants in sediments on the aquatic ecosystem and human health	52	AN18/ 99 SE01/103
	WA28 Impact of suspended solids and sediment on stream uses and the transport and fate of suspended solids in streams and harbour/ nearshore environments	53	SE01/103
	WA29 Impact of organic compounds in pulp and paper discharges on aquatic life and fish consumption by humans	54	AN18/ 99 SE01/103
Drinking Water	WA30 Removal capabilities of treatment techniques for specific trace contaminants in drinking water	55	

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
Drinking Water (continued)	WA31 Drinking water quality objectives and treatment processes	56	
	WA32 Determination of the extent and significance of nitrate contamination of aquifers in relation to future development of individual and/or communal groundwater supplies	57	
Effects of Acidic Deposition	WA33 Effects of acidification on biota	58	
	WA34 Contaminant uptake by biota in acid - stressed systems	59	
Other	WA35 Paucity of epidemiological information relating pathogens and their effects on humans and other animals by ingestion and by other means (e.g. recreational)	60	
	WA36 Development of risk and reliability methods for evaluating wastewater assimilation	61	SE01/103

WATER QUALITY RESEARCH: INDUSTRIAL WASTEWATER TREATMENT

ISSUE: WA01

Efficiencies of selected conventional and advanced wastewater treatment systems currently used in the Ontario pulp and paper, steel and petroleum/petrochemical industry.

Type of Research Needed:*

- Establish and test the usefulness of surrogate chemical parameters for monitoring chlorinated organics in pulp and paper mill effluents.
- Development and assessment of Best Management Practices.
- Evaluation of toxicity to fish and other aquatic organisms and taste and odour/tainting potential of influent and effluent streams and identification of probable associations/correlations of these effects with the contaminants (and their levels) found.
- Based on identification and low-level quantification of selected contaminants of concern in the influent and effluent streams of a variety of treatment systems, compare the removal efficiencies of different systems and identify the major design and operating factors influencing removal.

***See Also:**

Analytical Method Development:	Drinking, Surface, Wastewater Analysis - **AN12**
Analytical Method Development:	Biological Analysis - **AN18**
Socio-Economic Research:	Costs of Controls and Mitigation - **SE02**

WATER QUALITY RESEARCH: INDUSTRIAL WASTEWATER TREATMENT

ISSUE: WA02

Efficiencies of selected conventional and advanced wastewater treatment systems used by industrial concerns discharging wastes to municipal sewer systems including:

- organic chemicals sector
- printing and publishing sector
- electrical and mechanical equipment
- waste recycling sector (including solvent, drum, oil, battery and metal recyclers)
- food and kindred products sector.
- manufacturing sector
- services sector

Type of Research Needed:*

- Based on identification and low-level quantification of selected contaminants of concern in the influent and effluent streams of a variety of treatment systems, compare removal efficiencies of different systems and identify major design and operating factors influencing removal.

- Development and assessment of best management practices.

***See Also:**

Analytical Method Development:	Drinking, Surface, Wastewater Analysis - **AN12**
Socio-Economic Research:	Costs of Controls and Mitigation - **SE02**

WATER QUALITY RESEARCH: INDUSTRIAL WASTEWATER TREATMENT

ISSUE: WA03

Hazardous chemicals in sewer systems.

Type of Research Needed:

- Study of the fate and transport of volatile organic compounds in sewer systems.
- Study of the fate and transport of odour compounds in sewer systems.

WATER QUALITY RESEARCH: INDUSTRIAL WASTEWATER TREATMENT

ISSUE: WA04

Treatment of hazardous wastes in sewer systems.

Type of Research Needed:*

- Development and assessment of technology for the control of volatile organics and odour compounds in sewer systems, pumping stations, and the headworks of STP's.

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*See Also:
Socio-Economic Research: Costs of Control and Mitigation - SE02

WATER QUALITY RESEARCH: INDUSTRIAL WASTEWATER TREATMENT

ISSUE: WA05

Emerging technologies for industrial process changes to reduce contaminant loading to waste streams.

Type of Research Needed:*

- Assessment of industrial processes to reduce toxic loadings to wastewater streams (eg. replacement of chlorine with oxygen delignification in pulp bleacheries).
- Evaluation of methods of spill control and of inplant treatment to reduce contaminant loading to waste streams.

***See Also:**

Air Quality Research:	Instrument Development and Application - **AR11**
Liquid and Solid Waste Research :	Waste Handling - **LS02**
Socio-Economic Research:	Costs of Controls and Mitigation - **SE02**
Socio-Economic Research:	Evaluation Tools and Applications - **SE03**

WATER QUALITY RESEARCH: MUNICIPAL WASTEWATER TREATMENT

ISSUE: WA06

Prediction of fate and removability of hazardous compounds in municipal water pollution control plants.

Type of Research Needed:*

- **Identification and use of surrogate compounds to determine fate and treatability of other compounds.**
- **Assessment of the fate, removability and stability of hazardous contaminants during and after sludge treatment.**
- **Grouping of hazardous substances using Quantitative Structure Activity Relationships (QSAR) or other techniques to categorize and reduce priority pollutant lists.**

***See Also:**

Analytical Method Development: Drinking, Surface, Wastewater Analysis - AN12

WATER QUALITY RESEARCH: MUNICIPAL WASTEWATER TREATMENT

ISSUE: WA07

Innovative sewage treatment process research.

Type of Research Needed:

- Assessment of the sequencing batch reactor, biological phosphorus removal and integrated sewage treatment and energy production plants.
- Use of bio-augmentation and bio-stimulation processes to improve the removal of organic contaminants by municipal STP, and their ability to withstand organic shock loads.
- Use of mixed biological/activated carbon process to improve hazardous contaminants removal.

WATER QUALITY RESEARCH: MUNICIPAL WASTEWATER TREATMENT

ISSUE: WA08

Development of compliance and monitoring tools

Type of Research Needed:*

- Innovative techniques and mechanisms to effectively monitor, identify (in field) and determine the source of a hazardous contaminant discharge from industrial, commercial or institutional premises.

- Assessment of the variability of effluent quality.

***See Also:**

Air Quality Research:	Instrument Development and Application - AR11
Analytical Method Development:	Drinking, Surface, Wastewater Analysis - AN09
Socio-Economic Research:	Evaluation Tools and Applications - SE03

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA09

Natural occurrence of some organic and inorganic contaminants (e.g. Heavy metals, phenols, fluorides, radioactive materials) in surface and ground waters.

Type of Research Needed:*

- Determination of sources, availability and significance of trace metals, fluoride, aromatics, radon from specific geological formations, (e.g. limestone, igneous rocks, oil-bearing shales).

- Evaluation of the significance of substances such as phenols produced by the decay of vegetation on aquatic life (tainting, toxicity).

*See Also:
Analytical Method Development: Air and Water Analysis - AN16

WATER QUALITY RESEARCH : MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA10

The impact of agricultural tile drainage on receiving watercourses.

Type of Research Needed:

- Evaluation of nutrients and solids transport under varying cropping and tillage conditions.
- Study of the effects of tile drainage and open ditches on peak flows and dry weather flows.

WATER QUALITY RESEARCH : MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA11

Agricultural nutrient sources and transport.

Type of Research Needed:*

- Investigation of the relationship between agricultural tillage systems and phosphorus yields.
- Study of phosphorus transport, retention and transformation processes in a Great Lakes tributary (biogeochemical cycling), and evaluation of erosion and sediment control implications.
- Investigation of bacterial dynamics, especially die-off rates in flowing water and lacustrine environments.
- Development of practical airborne remote sensing techniques for assessing dry weather and wet weather agricultural pollutant discharges from farm sites.

*See Also:
Air Quality Research: Atmospheric Processes - AR04

WATER QUALITY RESEARCH : MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA12

Pesticide residues in tributaries and their impact on the inland water system and Great Lake connecting channels.

Type of Research Needed:

- Frequency and trends in detections of pesticides in water, sediment and biota of selected tributaries (Grand/Saugeen/Thames).
- Method to evaluate cause and effect relationship.
- Screening model to evaluate likely management scenarios.

WATER QUALITY RESEARCH : MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA13

Quantifying uncertainty in nutrient/contaminant loadings in-stream and its projected impact on the Great Lakes.

Type of Research Needed:

- Stochastic analysis of ambient water quality data.
- Impact of uncertainty in long-term phosphorus loadings to Great Lakes.
- Model development/implementation to investigate remedial measures scenarios.

WATER QUALITY RESEARCH: MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA14

Remedial measures to minimize the impact of agricultural practices on water quality.

Type of Research Needed:

- Development of domestic waste treatment systems which function well in poorly drained soils.

- Documentation of the impact of vegetative buffer strips adjacent to streams and municipal drains on water quality.

- Development of assessment techniques to evaluate the effectiveness of livestock controls and agricultural waste management practices on receiving water quality with respect to bacteria, phosphorus, and sediment loads.

WATER QUALITY RESEARCH : MANAGING NON-POINT SOURCES OF POLLUTION

ISSUE: WA15

Characterization of the hazardous contaminants in combined sewage overflows (CSO's) and stormwater runoffs (SWR's) and development of optimal control options.

Type of Research Needed:

- Definition of the relationship between land-use pattern (i.e. industrial, residential and commercial uses) and the type and concentrations of hazardous contaminants in CSO's and SWR's.

- Definition of the distribution of hazardous contaminants between settleable and non-settleable solids plus liquid phases in CSO's and SWR's.

- Definition of the relationship between concentrations of hazardous contaminants in CSO's and duration of overflows (i.e. the hydrographs).

- Determination of the rate of accumulation of hazardous contaminants on urban land surfaces.

- Investigation of the removability of selected hazardous contaminants in CSO's and SWR's by conventional means (e.g. solids removal and/or street sweeping).

- Derivation of innovative techniques and mechanisms to effectively monitor and control hazardous contaminant discharges into sewer systems.

- Evaluation of innovative techniques to remove or fix contaminants in surface water runoff.

WATER QUALITY RESEARCH : CONTAMINANT FATE AND TRANSPORT PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA16

Persistence, migration and breakdown processes of select hazardous contaminants in soil and groundwater.

Type of Research Needed:*

- Laboratory and field tests of half-life and migration of hazardous contaminants in the various soil and groundwater conditions found in Ontario, including the effects of complex mixtures that might be found in industrial waste disposal sites; (e.g. additive effects of several substances or increased mobility due to the presence of solvents).

*See Also:

Air Quality Research:	Contaminant Effects/Toxicity/Fates - AR03
Liquid and Solid Waste Research:	Groundwater Contamination - LS15
Analytical Methods Development:	Air and Water Analysis - AN16

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT PROCESSES IN AQUATIC SYSTEMS.

ISSUE: WA17

Prediction of currents from wind data at locations where no current meters have been operated.

Type of Research Needed:

- Designing a model using wind and current data from the Great Lakes nearshore areas in order to predict current directions (at surface and at depth)and speed for dispersion studies without the need for actual current measurements.

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA18

Development of a numerical/mathematical model to predict the the extent and water quality of a river plume where it merges in a lake.

Type of Research Needed:

- Design and testing of a model to handle one or more rivers with or without point sources under different climatological conditions (e.g. high flow period, ice cover etc.).

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA19

Development of a numerical/mathematical model to predict the hydrodynamics of the whole lake and then focus on a local area for better resolution.

Type of Research Needed:

- Calibration and verification of a wind-driven model for the Great Lakes. The local area model should have a hydrodynamic and water quality capability to assess the impact of various discharges. Model to be user friendly on MOE microcomputers.

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA20

Defining the fate and transport of bacteria, organic and inorganic compounds in the nearshore Great Lakes environment by incorporating the effects of physical processes.

Type of Research Needed:

- Development of computer simulations and modelling techniques in the nearshore Great Lakes by studying the dispersion patterns of near-field and far-field discharges (industrial and municipal outfalls).

- Evaluation of the implications of no or seasonal chlorination at STP's.

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA21

Fate and pathways of in-stream pollutants associated with suspended sediments.

Type of Research Needed:

- Investigation of the relationships between metal levels in suspended sediment, their geochemical distribution and factors that influence them (pH, hardness).
- Investigation of the biological significance of contaminants associated with suspended sediments.
- Investigation of the contribution of sediment entrainment in rivers to bacterial levels.
- Investigation of the relationship between suspended sediments and organic contaminant levels.

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA22

Model development for mine tailing discharge assimilation.

Type of Research Needed:*

- Model implementation in Serpent River for various management scenarios.
- Evaluation of the availability of metals in drainage from mine tailings areas.

*See Also:
Air Quality Research: Atmospheric Processes - AR04

WATER QUALITY RESEARCH: CONTAMINANT FATE AND TRANSPORT PROCESSES IN AQUATIC SYSTEMS

ISSUE: WA23

Distribution and behaviour of mercury in aquatic systems.

Type of Research Needed:

- Assessment of mercury methylation/demethylation rates in oligotrophic softwater lakes and their watersheds.
- Development of empirical models to describe the partitioning of mercury and methyl mercury in watershed soils, streams and oligotrophic softwater lakes.

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON AQUATIC SYSTEMS

ISSUE: WA24

Biological response to contamination from industrial and municipal discharges.

Type of Research Needed:*

- Evaluation of existing In-situ and ecosystem indicators of water quality impairment, identification of gaps and recommendation of methods to fill the gaps.
- Development of predictive toxicological-dose response relationship for populations/communities of aquatic organisms based on contaminant structure.
- Development of routine procedures for measurement of biochemical and physiological stress in organisms exposed to contaminants.
- Mutagenic and carcinogenic testing related to aquatic populations.
- Development and calibration of mathematical models of methyl mercury accumulation by aquatic biota to clarify factors influencing uptake and elimination.
- Evaluation of the significance of elevated levels of heavy metals and organic compounds on the growth and reproductive success of aquatic organisms.
- Assessment of the importance of modifying factors (hardness, pH, temperature) on the toxicity of metals and other substances.
- Significance (short and long term) of recent increases in nitrogen levels in Great Lakes and tributary waters.
- Evaluation of responses to decreasing phosphorus levels in the Great Lakes system.
- Procedures for determining and modelling the toxic effects of mixtures of chemicals found in effluents and ambient waters.

continued. . .

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON AQUATIC SYSTEMS

ISSUE: WA24(continued)

- Development of surrogates for rapid and effective monitoring of hazardous waste discharges.
- Evaluation of the effects of bioaccumulated organics and metals on the health of aquatic organisms at various levels in the food chain, leading to development of guidelines for biological organisms.
- Food chain dynamics of contaminants. What is the significance of uptake via ingestion vs uptake directly from water?

***See Also:**

Air Quality Research:	Contaminant Effects/Toxicity/Fate - **AR02**
Analytical Method Development;	Drinking, Surface, Wastewater Analysis - **AN12**
Analytical Method Development:	Biological Analysis - **AN18**
Socio-Economic Research:	Environmental Damages and Benefits - **SE01**

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON AQUATIC SYSTEMS

ISSUE: WA25

Aquatic macrophyte and algal responses to anthropogenic and other controlling factors and the role of aquatic plants in nutrient and contaminant cycling in the aquatic environment.

Type of Research Needed:

- Relationship of shading effects of phytoplankton to macrophyte growth in nutrient rich lakes.
- Assessment of year-to-year variability of Dicotomosiphon growth and distribution in Lake Simcoe and determination of light requirements for this benthic alga.
- Control of potentially toxic blue-green algae by stimulating more balanced populations through phosphorus reduction or nitrogen manipulation.
- Factors affecting metal accumulation in filamentous algae in Georgian Bay and softwater lakes and the significance and fate of metals subject to bioaccumulation.
- Assessment of relationship between acidity and phosphorus utilization in acidic lakes, including phosphatase activity, herbivore effects and light, pH and inorganic carbon requirements.
- Development of simple techniques for identifying species and forms based on electrophoretic/enzymatic procedures.

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON AQUATIC SYSTEMS

ISSUE: WA26

Statistical significance in contaminant sampling.

Type of Research Needed*

- Statistical design for identifying non-compliance with Provincial Water Quality Objectives in areas of impact.
- Definition and evaluation of approaches to dealing with values less than the detection limit in a statistical data base.
- Procedures for optimizing sampling frequency for determining contaminant loadings for point source discharges and total contaminant loads to lake basins (e.g. Lake Ontario).

See Also:

Socio-Economic Research: Evaluation Tools and Applications - SE03

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON AQUATIC SYSTEMS

ISSUE: WA27

The impacts of in-place pollutants in sediments on the aquatic ecosystem and human health.

Type of Research Needed:*

- Measurements of uptake by and release from sediments of trace substances.
- Transformation of trace organics and inorganics in sediments.
- Availability of trace organics and heavy metals in sediments to biota.
- Measurement and modelling of sediment resuspension and redistribution due to wave action, storms and currents.
- Development of criteria for evaluation and control of pollutants in sediments of receiving waters.
- Contaminant breakdown processes in sediments, such as biodegradation.
- Immobilization techniques such as chemical fixation, overlaying with clean segment.
- Effectiveness of alternate approches to isolating, removing, treating and/or disposing of contaminated sediments.
- Evaluation and case histories of "natural" restoration processes (eg. Hg - English Wabigoon, St. Clair River).
- Development of simple, reliable, laboratory based techniques to evaluate the potential impacts of in-place pollutants on the aquatic ecosystem.

***See Also:**

Analytical Method Development:	Biological Analysis - **AN18**
Socio-Economic Research:	Environmental Damages and Benefits - **SE01**

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON AQUATIC SYSTEMS

ISSUE: WA28

Impact of suspended solids and sediment on stream uses and the transport and fate of suspended solids in streams and harbour/nearshore environments.

Type of Research Needed:*

- Predictive models to identify depositional areas and areas of resuspension and transport in streams and the nearshore zone of the Great Lakes.
- Significance of suspended solids on fish health (gill clogging, feeding behaviour, growth, etc.) leading to a suspended solids or turbidity objective.
- Bioavailability of metals and organics associated with suspended particulates.

***See Also:**

Socio-Economic Research: Environmental Damages and Benefits - SE01

WATER QUALITY RESEARCH: IMPACTS OF POLLUTANT DISCHARGES ON AQUATIC SYSTEMS

ISSUE: WA29

Impact of organic compounds in pulp and paper discharges on aquatic life and fish consumption by humans.

Type of Research Needed:*

- Developmental work to identify and quantify compounds of significance, followed by assessment of effects on aquatic life.
- Toxicity, uptake and depuration rate studies are required relative to industrial and in-place pollutants.
- Identification of tainting compounds.
- Study of the toxicity of effluent from thermomechanical pulping and sulfite mills, for use in establishing criteria for mill effluents.
- Development of alternative technology for detoxification and treatment of effluents.
- Development of rapid, selective testing procedures for the analysis of trace organics in pulp and paper effluents for chemicals specific to the industry followed by assessment of effects on aquatic life.

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*See Also:

Analytical Method Development:	Biological Analysis - AN18
Socio-Economic Research:	Environmental Damages and Benefits - SE01

WATER QUALITY RESEARCH: DRINKING WATER

ISSUE: WA30

Removal capabilities of treatment techniques for specific trace contaminants in drinking water.

Type of Research Needed:

- Evaluation of the effectiveness of innovative treatment techniques (such as resin adsorption, reverse osmosis, aeration, biological filtration, GAC, PAC, ozonation and treatment train modifications) for hazardous contaminant removal.

- Protocol development for the assessment of treatment methodologies for groups of compounds and specific trace contaminants.

- Development of a computer assisted treatment process choice for use as a decision making framework for the removal/reduction of trace contaminants from drinking water.

WATER QUALITY RESEARCH: DRINKING WATER

ISSUE: WA31

Drinking water quality objectives and treatment processes.

Type of Research Needed:

- Provision of information required for the development of drinking water quality objectives for MOE list of priority chemicals.
- Use of mutagenicity testing in assessing drinking water treatment processes - effectiveness/efficiency of treatment.
- Development of a means of predicting/establishing short-term variations in water quality at intakes and establishing subsequent treatment technology.
- Investigation of the by-products of the use of alternative treatment processes.
- Investigation of the production of additional contaminants in finished water because of the application of chlorine to water containing traces of contaminants (eg trichlorotoluene from water containing toluene).

WATER QUALITY RESEARCH: DRINKING WATER

ISSUE: WA32

Determination of the extent and significance of nitrate contamination of aquifers in relation to future development of individual and/or communal groundwater supplies.

Type of Research Needed:

- Study of the total nitrate loading on aquifers from septic system effluents, fertilizers and any other potential sources.
- Study of the magnitude of seasonal nitrate level fluctuations in different aquifers (shallow end intermediate).
- Development of protocol to estimate total nitrate loading expected from proposed and existing development.
- Research the need and feasibility of nitrate removal systems in communal systems and/or for small private systems.
- Investigation of the use of nitrate as an indicator parameter for other potential contaminants, especially organics originating from septic effluents.

WATER QUALITY RESEARCH: EFFECTS OF ACIDIC DEPOSITION

ISSUE: WA33

Effects of acidification on biota.

Type of Research Needed:

- Determination of the extent and mechanisms responsible for the occurrence of spring mortality in populations of biota in soft water lakes.
- Investigation of the causes of fish population anomalies such as recruitment failure in low alkalinity lakes.
- Determination of the effects of surface water acidification on fish populations in running water and a definition of mechanisms of population loss.

WATER QUALITY RESEARCH: EFFECTS OF ACIDIC DEPOSITION

ISSUE: WA34

Contaminant uptake by biota in acid-stressed systems.

Type of Research Needed:

- Determination of mechanisms of metal enrichment of the food chain of acidified lakes.
- Determination of extent and significance of bioaccumulation of organic contaminants associated with long range transport and an elucidation of pathways from atmosphere to aquatic biota.
- Determination of metal enrichment (eg. Hg, Cd) in various waterfowl and their prey species.
- Determination of metal (Cd) accumulation in moose, deer and other game species in buffered and non-buffered areas. Dertermination of pathways of metal accumulation in forage species.

WATER QUALITY RESEARCH: OTHER

ISSUE: WA35

Paucity of epidemiological information relating pathogens and their effects on humans and other animals by ingestion and by other means (e.g. Recreational).

Type of Research Needed:

- Relationships between indicator organisms and human epidemiology.
- Resistance of specific pathogens to disinfection practices in drinking and waste water treatment plants.
- What represents an effective dose of major waterborne pathogens on humans?
- Impact of pathogens on aquatic and domestic animals.
- Definition of the significance/effects of photo-reactivation of indicator organisms and pathogens in surface waters which receive sewage effluent.
- Disinfection by means of ultraviolet light plus either ozone or peroxide.
- Examination of strategies for improving the reporting of waterborne disease.

WATER RESEARCH CATEGORY: OTHER

ISSUE: WA36

Development of risk and reliability methods for evaluating wastewater assimilation.

Type of Research Needed:*

- Performance analysis of reservoir operation in lowflow augmentation.
- Bayesian risk decision in quantity and quality design criteria.
- Reliability and trends in loadings in Ontario tributaries.

*See Also:
Socio-Economic Research: Environmental Damages and Benefits - SE01

SUMMARY OF LIQUID AND SOLID WASTE RESEARCH ISSUES

RESEARCH CATEGORY	ISSUES		PAGE NUMBER	RELATED ISSUES AND PAGE NO
LIQUID AND SOLID WASTE RESEARCH				
Waste Handling	LS01	Characterization of waste materials and the determination of the behaviour of wastes under various and varying conditions	64	AN01/ 82
	LS02	Methods and materials for the treatment of wastes and waste by-products	65	AR13/ 17 WA05/ 29 SE02/105
	LS03	Methods and materials for the destruction of wastes and waste by-products	66	AR04/ 8 AR08/ 12 AR11/ 15 AR13/ 17 AN15/ 96 AN17/ 98 SE02/105
	LS04	Methods for the ultimate disposal of wastes and waste by-products	67	SE02/105
Waste Reduction	LS05	Ways and means of reducing the volumes of waste streams	68	SE02/105 SE03/106
	LS06	Ways and means of recycling materials currently in the waste stream	69	SE02/105 SE03/106
	LS07	Ways and means of recovering usable materials currently in the waste stream	70	SE02/105 SE03/106 SE04/107

RESEARCH CATEGORY	ISSUES		PAGE NUMBER	RELATED ISSUES AND PAGE NO
Waste Reduction (continued)	LS08	Ways and means of re-using materials diverted from current waste stream	71	SE02/105 SE03/106 SE04/107
Landfill Technology	LS09	Wastes and types of wastes being landfilled	72	AN15/ 96 SE02/105
	LS10	Methods, materials and performance of landfill covers	73	
	LS11	Methods, materials and performance of landfill liners	74	
	LS12	Characteristics and impacts of landfill leachate	75	AN15/ 96
	LS13	Production, control, collection and disposal of landfill gas	76	AR11/ 15 SE01/103
	LS14	End-use of closed landfills	77	
	LS15	Groundwater contamination from landfills	78	WA16/ 40 AN14/ 95 AN16/ 97

LIQUID AND SOLID WASTE RESEARCH: WASTE HANDLING

ISSUE: LS01

Characterization of waste materials and the determination of the behaviour of wastes under various and varying conditions.

Type of Research Needed:*

- Determination of "inert" wastes.
- Long term effects of wastes.
- Studies on toxic hazardous waste schedules including:
  - Assessment of existing hazardous waste schedules,
  - development of criteria for listing of hazardous waste based on toxicological studies (chronic and acute toxicity, persistence, bioaccumulation, leachability, etc.).
- Development of test criteria to define "ignitable" and "reactive" waste characteristics.
- Study of long term leachability of municipal wastes.

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*See Also:

Analytical Method Development:	Refinement of Analytical Techniques - AM01

LIQUID AND SOLID WASTE RESEARCH: WASTE HANDLING

ISSUE: LS02

Methods and materials for the treatment of wastes and waste by-products.

Type of Research Needed:*

- Biological, chemical, physical treatment processes for solid and liquid wastes.
- Methods for solidification and/or encapsulation.
- Disposal of treatment process effluent.
- Development of functional relationships to characterize changes and/or reductions for specific waste/treatment configurations.

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*See Also:

Air Quality Research:	Control and Remedial Technology - AR13
Water Quality Research:	Industrial Wastewater Treatment - WA05
Socio-Economic Research:	Costs of Controls and Mitigation - SE02

LIQUID AND SOLID WASTE RESEARCH: WASTE HANDLING

ISSUE: LS03

Methods and materials for the destruction of wastes and waste by-products.

Type of Research Needed:*

- **The destruction of municipal and industrial wastes by incineration, including:**
  - **improvements to state-of-the-art technology;**
  - **field and laboratory studies;**
  - **technology for destruction and disposal of municipal and industrial wastes;**
  - **characterization of incinerator ash, its leachability and utilization or disposal;**
  - **effectiveness of existing incineration facilities;**
  - **emission monitoring of hazardous contaminants;**
- **Non-thermal destruction of municipal and industrial wastes including:**
  - **mechanical processes**
  - **chemical processes**
- **Non-incineration, thermal destruction process.**

***See Also:**

Air Quality Research:	Atmospheric Processes - **AR04**
Air Quality Research:	Sources/Inventories - **AR08**
Air Quality Research:	Instrument Development and Application - **AR11**
Air Quality Research:	Control and Remedial Technology - **AR13**
Analytical Method Development:	Landfill, Leachate, Effluent, Hazardous Waste Analysis - **AN15**
Analytical Method Development:	Air Analysis - **AN17**
Socio-Economic Research:	Costs of Controls and Mitigation - **SE02**

LIQUID AND SOLID WASTE RESEARCH: WASTE HANDLING

ISSUE: LS04

Methods for the ultimate disposal of wastes and waste by-products.

Type of Research Needed:*

- Ultimate fate of wastes and waste by-products.
- Impact of land application of wastes including effects on the quality of surface and groundwater and of soils.
- Accumulation and cumulative effects of non-degradable contaminants on land.
- Study of "small quantity" waste disposal methods and practices, including definition of small quantity for specified materials.
- Development of criteria for waste-derived fuel (WDF).
- Risk assessment of disposal methods.

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*See Also:
Socio-Economic Research: Costs of Controls and Mitigation - SE02

LIQUID AND SOLID WASTE RESEARCH: WASTE REDUCTION

ISSUE: LS05

Ways and means of reducing the volumes and contaminated mass of waste streams.

Type of Research Needed:*

- Post-consumer.
- Commercial.
- Industrial.
- Municipal.
- Processing/packaging.
- Study of feasibility and need for segregating and stockpiling or selectively disposing of wastes in landfills for energy generation or possible future re-use.

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*See Also:

Socio-Economic Research:	Costs of Controls and Mitigation - SE02
Socio-Economic Research:	Evaluation Tools and Applications - SE03

LIQUID AND SOLID WASTE RESEARCH: WASTE REDUCTION

ISSUE: LS06

Ways and means of recycling materials currently in the waste stream.

Type of Research Needed:*

- Treatment to improve purity.
- Processing to alter compounds or characteristics of materials in the waste stream.

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*See Also:

Socio-Economic Research:	Costs of Controls and Mitigation - SE02
Socio-Economic Research:	Evaluation Tools and Applications - SE03

LIQUID AND SOLID WASTE RESEARCH: WASTE REDUCTION

ISSUE: LS07

Ways and means of recovering usable materials currently in the waste stream.

Type of Research Needed:*

- **Treatment of recovered material to protect and ensure purity**
- **Processing of recovered material for direct reuse**
- **Processing of recovered material for indirect and/or downstream use**

***See Also:**

Socio-Economic Research:	**Costs of Controls and Mitigation - SE02**
Socio-Economic Research:	**Evaluation Tools and Applications - SE03**
Socio-Economic Research:	**Environmental Protection Industry - SE04**

LIQUID AND SOLID WASTE RESEARCH: WASTE REDUCTION

ISSUE: LS08

Ways and means of re-using materials diverted from current waste stream.

Type of Research Needed:*

- Integration of re-use materials into production streams
- Innovative re-use of waste materials
- Cross-industry sharing of reusable waste materials

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*See Also:

Socio-Economic Research:	Costs of Controls and Mitigation - SE02
Socio-Economic Research:	Evaluation Tools and Applications - SE03
Socio-Economic Research:	Environmental Protection Industry - SE04

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS09

Wastes and types of wastes being landfilled.

Type of Research Needed:*

- Determination of acceptable wastes.
- Determination of the effects of wastes on landfills.
- Investigation of rates of degradation and decomposition.
- Enhanced treatment in landfills.
- Serial leaching and its effects.

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*See Also:

Analytical Method Development:	Landfill, Leachate, Effluent, Hazardous Waste Analysis - AN15
Socio-Economic Research:	Costs of Controls and Mitigation - SE02

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS10

Methods, materials and performance of landfill covers.

Type of Research Needed:

- Development and evaluation of landfill cover designs in terms of:

  - materials
  - thickness
  - shape
  - infiltrative capacity
  - durability
  - rehabilitation and/or replacement

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS11

Methods, materials and performance of landfill liners.

Type of Research Needed:

- Development and evaluation of landfill liner designs in terms of:

  - materials
  - thickness
  - shape
  - leakage
  - etc.

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS12

Characteristics and impacts of landfill leachate.

Type of Research Needed:*

- Methods for collection, control and treatment of leachate.
- Efficiency of purge wells.
- Plugging of leachate collection systems.
- Attenuation of leachate in groundwater.

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*See Also:
Analytical Method Development: Landfill, Leachate, Effluent, Hazardous Waste Analysis - AN15

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS13

Production, control, collection and disposal of landfill gas.

Type of Research Needed:*

- Development of a method to assess methane flux.
- Specific measurement of ventilation rates and flux.
- Long term gas production.
- Collection and utilization as an energy source.
- Methods to enhance gas production rate.

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*See Also:

Air Quality Research:	Instrument Development and Application - AR11
Socio-Economic Research:	Environmental Damages and Benefits - SE01

LIQUID AND SOLID WASTE RESEARCH: LANDFILL TECHNOLOGY

ISSUE: LS14

End-use of closed landfills.

Type of Research Needed:

- Development of closure techniques.
- Monitoring systems and materials for long term use.
- Construction methods on closed landfills.
- Legal and institutional impediments to future use.

LIQUID AND SOLID WASTE RESEARCH: GROUNDWATER CONTAMINATION

ISSUE: LS15

Groundwater contamination from landfills.

Type of Research Needed:*

- Effects of leachates.
- Effects of chemical spills.
- Development of methods for the improved detection and tracing of contaminant plumes.
- Improved prediction of plume development and movement.
- Remediation methods and materials.

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*See Also:

Water Quality Research:	Contaminant Fate and Transport Processes in Aquatic Systems - WA16
Analytical Method Development:	Landfill Leachate, Effluent, Hazardous Waste Analysis - AN14
Analytical Method Development:	Air and Water Analysis - AN16

SUMMARY OF ANALYTICAL METHOD DEVELOPMENT ISSUES

RESEARCH CATEGORY	ISSUES		PAGE NUMBER	RELATED ISSUES AND PAGE NO
ANALYTICAL METHOD DEVELOPMENT				
Refinement of Analytical Techniques	AN01	Improved specificity of detection for the quantitative analysis of ultra-trace amounts of organic compounds in complex mixtures (for example pulp and paper effluents)	82	LS01/ 64
	AN02	Unambiguous identification of organic compounds in the environment	83	
	AN03	Automation of Analytical Methods: improve sample throughput and analytical precision by automation of sample preparation; improve speed of GC or GC-MS interpretation for quantitative target compound analysis or for complex mixtures such as environmentally altered PCBs, toxaphene and chloronapthalene	84	
	AN04	Determination of sample integrity and stability during shipping or storage, with time	85	
	AN05	Investigations of sample integrity after sub-aliquoting/ homogenization	86	

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
Refinement of Analytical Techniques (continued)	AN06 Preparation of high quality, validated analytical standards and standard reference materials	87	
	AN07 Development of expert systems to improve analytical performance in situations where a large number of decisions must be made, for example, interpretation of ICP source mass spectrometry or GC mass spectrometry	88	
	AN08 Application of complex mathematical techniques towards optimizing analytical methodology	89	
Drinking, Surface, Wastewater Analysis	AN09 Broad spectrum screening for contaminants in drinking, surface and wastewaters	90	WA08/ 32
	AN10 Evaluate applicability of existing analytical techniques to complex waste and industrial samples	91	
	AN11 Development of sampling systems (large volume and/or resin) for preconcentration of low (ppt, ppq) levels of toxic contaminants in surface and drinking waters prior to analysis	92	

RESEARCH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
Drinking, Surface, Wastewater Analysis (continued)	AN12 Surrogate parameters for water monitoring	93	WA01/ 25 WA02/ 26 WA06/ 30 WA24/ 48
	AN13 Development and validation of sampling protocols for contaminants in surface and drinking waters	94	
Landfill Leachate, Effluent, Hazardous Waste Analysis	AN14 Tiered testing of ground-water for landfill investigations	95	LS15/ 78
	AN15 Investigation and development of laboratory techniques to assess leaching potential of specific wastes for hazardous waste classification	96	LS03/ 66 LS09/ 72 LS12/ 75
Air and Water Analysis	AN16 Techniques which apply development of isotope ratios and isomer distribution patterns to source tracking of pollutants	97	AR06/ 10 WA09/ 33 WA16/ 40 LS15/ 78
Air Analysis	AN17 Sampling and analysis of gaseous and particulate emissions in air	98	AR08/ 12 AR11/ 15 LS03/ 66
Biological Analysis	AN18 Biological toxicity testing	99	AR07/ 11 WA01/ 25 WA24/ 48 WA27/ 52 WA29/ 54
	AN19 Genotoxicity testing	100	

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF ANALYTICAL TECHNIQUES

ISSUE: AN01

Improved specificity of detection for the quantitative analysis of ultra-trace amounts of organic compounds in complex mixtures. (for example pulp and paper effluents)

Type of Research Needed:*

- Improved resolution in gas chromatography (GC) through development of new columns with novel stationary phases with high selectivity for priority pollutants.

- Construction of novel GC detectors or improving selectivity of conventional GC detectors for hazardous compounds.

- New and improved chemical techniques for the isolation of target compounds from complex matrices of many other compounds including structurally similar species that interfere with GC and GC-MS analysis. Includes wet chemical techniques, GPC, HPLC and other chromatographic separations.

- Extension of existing methods to handle new types of samples or target analytes.

- Develop rapid speciation methods for the toxic 2,3,7,8-substituted congeners of chlorinated dibenzo-p-dioxins and dibenzofurans in complex mixtures containing both toxic and non-toxic congeners.

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*See Also:
Liquid & Solid Waste Research: Waste Handling - LS01

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF ANALYTICAL TECHNIQUES

ISSUE: AN02

Unambiguous identification of organic compounds in the environment.

Type of Research Needed:

- Improvements of GC-MS and other instrumental techniques for rapid broad-spectrum compound identification in extremely complex mixtures.
- Improvements in identification of unknown organics from mass spectral information when library search methods are inadequate.
- Development of mathematical and software fingerprinting techniques for rapid broad-spectrum compound identification in extremely complex mixtures.
- Identification using specialized mass spectrometric techniques such as positive and negative chemical ionization, exact mass determination, and MS-MS.
- Development of isolation and concentration techniques to obtain large quantities of unknown components to enable a wide variety of spectroscopic techniques to be used for compound identification.
- Develop instrumental analysis procedures to supplement GC-MS identification; including fourier-transform infra-red spectroscopy, interfaced to GC high performance liquid chromatography, nuclear magnetic resonance, and other specialized detectors for low level qualitative/quantitative analysis.
- Improvements to existing separatory techniques for superior fractionation of complex sample matrices for instrumental analysis (e.g. GC/MS, FTIR).

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF ANALYTICAL TECHNIQUES

ISSUE: AM03

Automation of Analytical Methods: improve sample throughput and analytical precision by automation of sample preparation; improve speed of GC or GC-MS interpretation for quantitative target compound analysis or for complex mixtures such as environmentally altered PCBs, toxaphene, chloronapthalene.

Type of Research Needed:

- Develop software techniques to improve reliability of automated identification of trace levels of analytes using a few characteristic ion masses by selected ion monitoring or a series of peak retention times and relative responses (SIMCA).

- Improve software methods for automated target compound quantitation using external or internal standardization and automated report generation for GC/MS.

- Develop customized software packages for GC-MS data interpretation for specific Ministry programs, including specialized data bases.

- Develop identification procedures using combined retention time and mass spectral data for GC/MS.

- Application of robotics to sample preparation operations, especially where sample mixing is required. Use of air or nitrogen for mixing is not acceptable; process must avoid cross contamination.

- Development of new extraction/wet chemical techniques more readily adapted to automation.

- Adaptation of existing chemical cleanup methods to automated procedures.

- Investigation and refinement of super critical fluid extraction and preparative chromatography techniques.

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF ANALYTICAL TECHNIQUES

ISSUE: AN04

Determination of sample integrity and stability during shipping, storage with time.

Type of Research Needed:

- Determination of optimum conditions for shipping samples including time limitations, temperature effects, container design, addition of preservatives during sampling.
- Determine sample integrity during length of storage time under different conditions, especially for volatile organic compounds.
- Determine sample integrity during storage including time limitations, temperature effects, addition of preservatives, especially for inorganic parameters such as phenolics, nutrients, and alkalinity and for organics such as dioxins, PCBs, orngano-chlorines, PAH, chlorobenzenes; sample matrices of interest are ground waters, surface waters, leachates and fish sediments.
- Comprehensive assessment of the stability with time of all inorganic and organic parameters routinely reported by MOE.
- Study design, associated analysis, report presentation.
- Development of improved procedures where current techniques prove inadequate.

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF ANALYTICAL TECHNIQUES

ISSUE: AN05

Investigations of sample integrity after sub-aliquoting/ homogenization.

Type of Research Needed:

- Investigation of the effects of grinding, slicing, mixing, blending on homogeneity of sample and particle sizes.
- Studies of analyte losses through sample homogenization steps or artifact introduction (i.e. trace metals using metal blender blades).
- Investigation of the homogeneity of an aqueous sample in the presence of suspended particulates during sample sub-aliquoting.
- Problems associated with splitting filter and polyurethane foam cartridged samples for air particulate.
- Analytical development of protocol for sub-aliquoting complex samples for round robin samples.

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF ANALYTICAL TECHNIQUES

ISSUE: AN06

Preparation of high quality, validated analytical standards and Standard Reference Materials (SRM's).

Type of Research Needed:

- Synthesis, purification quantification and validation of standard reference compounds such as dioxins, furans, PAH's, acetylated and methylated phenols, phenoxy, herbicides speciated phenols and acetylated nitrophenols as required for MOE laboratories and not available commercially.

- Methods for validating standard concentrations.

- Protocols for preparation, storage and use of analytical standards (long term stability of standard solutions). Including ampouling freezing, storage under argon, or other inert gas.

- SRM's are needed for many organics/sample types for which none are available commercially available. Specifically, SRM's are needed for chlorinated dibenzo-p-dioxins/dibenzofurans in soils, sediments, incinerator fly-ash and water organochlorines in sediments and biota.

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF ANALYTICAL TECHNIQUES

ISSUE: AN07

Development of expert systems to improve analytical performance in situations where a large number of decisions must be made, for example, interpretation of ICP source mass spectrometry or GC mass spectrometry.

Type of Research Needed:

- Using IBM PC type computers, design systems to aid in the processing of large amounts of data with the aid of using a rule based process to extract information.

ANALYTICAL METHOD DEVELOPMENT: REFINEMENT OF ANALYTICAL TECHNIQUES

ISSUE: AN08

Application of complex mathematical techniques towards optimizing analytical methodology.

Type of Research Needed:

- Development or application of simplex optimization to a variety of inorganic/organic methods to allow for analytical method development to be performed in the most efficient manner possible.

- Application of powerful mathematical techniques (including concepts from information theory) to allow for more efficient instrumental analysis: smoothing of data signal, to allow for better low level quantitation and data interpretation.

- these techniques could be applied to mass spectrometry and optical spectroscopy (IR - UV); must be able to run on IBM PCs and allow data entry in various forms including ASCII and LOTUS.

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE, WASTEWATER ANALYSIS

ISSUE: AN09

Broad spectrum screening for contaminants in drinking, surface and wastewaters.

Type of Research Needed:*

- Development of ICP/MS, GC-microwave plasma emission spectroscopy, Ion specific mass detector, Biological on-line monitoring for screening trace metals in a variety of environmental samples.

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*See also:
Water Quality Research: Municipal Wastewater Treatment - WA08

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE, WASTEWATER ANALYSIS

ISSUE: AN10

Evaluate applicability of existing analytical techniques to complex waste and industrial samples.

Type of Research Needed:

- Evaluate the possible interferences in the analysis of inorganic parameters in aqueous wastes from industrial operations.

- Investigation of matrix modification techniques to enhance specific analyte detectability and response.

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE, WASTEWATER ANALYSIS

ISSUE: AN11

Development of sampling systems (large volume and/or resin) for preconcentration of low (ppt, ppq) levels of toxic contaminants in surface and drinking waters prior to analysis.

Type of Research Needed:

- XAD and similar resin technology need to be extended and tested for a comprehensive range of trace organics. Rugged high flow field sampling systems need to be developed.
- Evaluation of the capacity of resin system to recover total organic loading from waters and waste waters.
- Effect of suspended particulate on the distribution and collection of organics in water.

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE, WASTEWATER ANALYSIS

ISSUE: AN12

Surrogate parameters for water monitoring.

Type of Research Needed:*

- Development and improvement of detection limits of surrogate parameters and correlation with specific and group toxic compounds in drinking and waste waters.
- Evaluation of effectiveness.

***See also:**

Water Quality Research:	Industrial Waste Water Treatment - WA01 - WA02
Water Quality Research:	Municipal Wastewater Treatment - WA06
Water Quality Research:	Impacts of Pollutant Discharges on Aquatic Systems - WA24

ANALYTICAL METHOD DEVELOPMENT: DRINKING, SURFACE, WASTEWATER ANALYSIS

ISSUE: AN13

Development and validation of sampling protocols for contaminants in surface and drinking waters.

Type of Research Needed:

- To determine significance of sampling protocols on analytical data.

  Protocols should also consider microbiological parameters other than the standard coliforms etc.

- Development/evaluation of samplers for collection of liquid samples (sewage effluent, drinking water, etc) for purgeable organic analysis.

- Evaluation of sampling and preservation techniques for purgeable and extractable organic analysis.

- For well waters, determine effect on pH and alkalinity measurements of time delay between sampling and analysis at laboratory.

ANALYTICAL METHOD DEVELOPMENT: LANDFILL LEACHATE, EFFLUENT, HAZARDOUS WASTE ANALYSIS

ISSUE: AN14

Tiered testing of ground-water for landfill investigations.

Type of Research Needed:*

- Development of a tiered testing protocol including validation of sample integrity for groundwater contaminant analysis.
- ruggedness testing and development/refinement of analysers for wastewaters, landfill leachates groundwater.

***See also:**
Liquid & Solid Waste Research: Groundwater contamination - LS15

ANALYTICAL METHOD DEVELOPMENT: LANDFILL LEACHATE, EFFLUENT, HAZARDOUS WASTE ANALYSIS

ISSUE: AN15

Investigation and development of laboratory techniques to assess leaching potential of specific wastes for hazardous waste classification.

Type of Research Needed:*

- Serial leaching of specific wastes to determine the effect on contaminant concentration.
- Development of a simplified procedure to determine the effect of long term (serial) leaching.
- Review of parameters such as pH, time, oxygen, liquid to solids ratio, etc. to improve the ability of the procedure to approximate actual site conditions.
- Investigation of alternate leaching procedures and development of procedures and protocols suitable for volatile and non-volatile organics.

***See Also:**

Liquid & Solid Waste Research:	Waste Handling - LS03
Liquid & Solid Waste Research:	Landfill Technology - LS09 - LS12

ANALYTICAL METHOD DEVELOPMENT: AIR & WATER ANALYSIS

ISSUE: AN16

Techniques which apply development of isotope ratios and isomer distribution patterns to source tracking of pollutants.

Type of Research Needed:*

- By applying advanced analytical techniques such as computerized GC/MS, FTIR, XRF, GC/MS, XRD, ICP/MS develop:

  . Methods for comparing profiles of organics/inorganics for generic identification for sample types such as coal tar.

  . Compare isomer distribution patterns for compounds such as PCBs, toxaphene dioxins to relate to source:

  (re: if compound A=B then source X; if compound >>> B then source Y)

  . Co-relate emission patterns to surrogates e.g. if compound A is present, then X, Y, Z probably there as well.

  . Co-relate isotope ratios of elements such as Pb to sources.

***See also:**

Air Quality Research:	Atmospheric Processes - **AR06**
Water Quality Research:	Managing Non-point sources of Pollution - **WA09**
Water Quality Research:	Contaminant Fate & Transport Processes in Aquatic System - **WA16**
Liquid & Solid Waste Research:	Groundwater contamination - **LS15**

ANALYTICAL METHOD DEVELOPMENT: AIR ANALYSIS

ISSUE: AN17

Sampling and analysis of gaseous and particulate emissions in air.

Type of Research Needed:*

- Broad spectrum screening methods to extend the range of compounds currently monitored to include odorous compounds such as mercaptans and amines and to provide a more rapid and cost effective approach to analysis of organic air pollutants.
- Further development of air sampling and analytical methods for both on and off-site measurements for semi-volatile and trace metals.
- Development of simple, rugged field analytical methods for landfill air contaminants emissions.
- Development of broad spectrum screening methods to extend the range of PAHs currently monitored with emphasis on specificity.
- Development of cost-effective analytical methods for PAHs, nitro PAH and PCDD.
- Improved sampling methods to determine the vapour/particulate distribution of PAH and PCDD in ambient air.
- Automation of sample preparation for air samples.

***See also:**

Air Quality Research:	Sources/Inventories - **AR08**
Air Quality Research:	Instrument Development & Application - **AR11**
Liquid & Solid Waste Research:	Waaste Handling - **LS03**

ANALYTICAL METHOD DEVELOPMENT: BIOLOGICAL ANALYSIS

ISSUE: AN18

Biological toxicity testing.

Type of Research Needed:*

- Standardized on-site integrative biological tests to identify potential problem areas in air, soil and water.
- Development of laboratory protocols for recovery, identification, and enumeration of pathogenic organisms (virus, bacteria, protozoa).
- Field methods for pre-concentration of viruses.

***See also:**

Air Quality Research:	Risk Management - **AR07**
Water Quality Research:	Including Wastewater Treatment - **WA01**
Water Quality Research:	Impacts of Pollutant Discharges on Aquatic Systems - **WA24 - WA27 - WA29**

ANALYTICAL METHOD DEVELOPMENT: BIOLOGICAL ANALYSIS

ISSUE: AN19

Genotoxicity testing.

Type of Research Needed:

- In-situ test systems needed to identify the presence of genotoxic compounds or conditions (mixture effects) in the environment.
- Screening tests that can be quickly and economically carried out on environmental samples are required for laboratory application.
- Relationships need to be developed between carcinogenicity and genotoxicity test response and human health effects.
- Effects of mixtures of resin acids/a single effects on fish etc; PH dependent; also in presence of chlorinated resin acids etc.

SUMMARY OF SOCIO-ECONOMIC RESEARCH ISSUES

RESEARH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
SOCIO-ECONOMIC RESEARCH			
Environmental Damages and Benefits	SE01 Quantification and valuation of pollution damages and disruptions and the benefits of environmental protection	103	AR01/ 5 AR02/ 6 AR03/ 7 WA24/ 48 WA27/ 52 WA28/ 53 WA29/ 54 WA36/ 61 LS13/ 76
Costs of Controls and Mitigation	SE02 Determination of the costs and other economic consequences of environmental protection and pollution abatement activities	105	AR04/ 8 AR08/ 12 AR10/ 14 AR12/ 16 AR13/ 17 AR14/ 18 WA01/ 25 WA02/ 26 WA03/ 27 WA04/ 28 WA05/ 29 LS02/ 65 LS03/ 66 LS04/ 67 LS05/ 68 LS06/ 69 LS07/ 70 LS08/ 71 LS09/ 72
Evaluation Tools and Applications	SE03 Development and application of procedures and methods to evaluate policies, programs and projects	106	AR07/ 11 WA05/ 29 WA08/ 32 WA26/ 51 LS05/ 68 LS06/ 69 LS07/ 70 LS08/ 71

RESEARH CATEGORY	ISSUES	PAGE NUMBER	RELATED ISSUES AND PAGE NO
Environmental Protection Industry	SE04 Assessment of the characteristics, structure and performance of environmental protection related industries and businesses	107	AR12/ 16 LS07/ 70 LS08/ 71
Social (Non-Economic) Implications	SE05 Social implications of environmental contaminants and their control	108	
Enviro-Economic Modelling	SE06 Development and testing of forcasting simulation and optimization models	109	AR04/ 8 AR06/ 10

SOCIO-ECONOMIC RESEARCH: ENVIRONMENTAL DAMAGES AND BENEFITS

ISSUE: SE01

Quantification and valuation of pollution damages and disruptions and the benefits of environmental protection

Type of Research Needed:*

- Conduct behavioral experiments to determine individuals' actual willingness-to-pay or willingness-to-accept-compensation values for specific environmental features or attributes.

- Compare the results of different valuation methodologies for similar non-market environmental goods or activities.

- Develop quantitative relationships between water quality measures/indicators and uses of water bodies for swimming, fishing, boating and other recreational activities.

- Develop and apply methods to produce inventories of various resources at risk.

- Develop and test procedures to quantify various types of environmental damages and to assign measures of relative importance.

- Determine the relative importance that people place on odours and the value people attribute to reductions in odours.

- Develop and apply methods to determine the relative importance people place on different types of risk and how much people value reductions in risk.

- Quantify and estimate the values of the beneficial (crop productivity, reductions in annoyance and health risk, etc.) and adverse (increased risk of contamination and health effects, damages to wildlife, etc.) effects of pesticide use.

- Develop estimates of damages of ground water contamination and the costs and benefits of its prevention or mitigation.

- Adapt or develop human health and risk dose-response relationship functions for toxic-hazardous waterborne and airborne compounds to predict and quantify damages from specific pollutants, economic activities or development projects.

continued. . .

SOCIO-ECONOMIC RESEARCH: ENVIRONMENTAL DAMAGES AND BENEFITS

ISSUE: SE01 (continued)

- Adapt or develop human health and risk dose-response relationships for toxic substances to predict and quantify the beneficial consequences that result from abatement and protection activities.

- Document the private benefits (e.g. recovered by-products, cost reductions, raw material and energy savings, product quality improvements, etc.) of industrial abatement technologies, systems, or programs.

- Compare methods of valuing marginal changes with those for valuing extinction, all or nothing situations or catastrophies.

***See Also:**

Air Quality Research:	Contaminant Effects/Toxicology/ Fates - AR01 - AR02 - AR03
Water Quality Research:	Impacts of Pollutant Discharges on Aquatic Systems - WA24 - WA27 - WA28 - WA29
Water Quality Research:	Other - WA36
Liquid and Solid Waste Research:	Landfill Technology - LS13

SOCIO-ECONOMIC RESEARCH: COSTS OF CONTROLS AND MITIGATION

ISSUE: SE02

Determination of the costs and other economic consequences of environmental protection and pollution abatement activities

Type of Research Needed:*

- Develop abatement cost functions for particular pollutants in specific industries which can be used in future studies and assessments.
- Estimation of the costs of environmental management projects and technologies for agricultural production.
- Estimation of the costs of controlling air emissions from fuel burning by households and commercial units.
- Analysis of demand characteristics and price elasticities for pollution abatement systems, services and equipment.
- Determine the motivating factors for industrial and municipal decision-makers with respect to abatement/environmental protection programs.
- Compare the costs and other implications of "up front" mine rehabilitation measures with post closure clean-up practices.
- Cost effectiveness of monitoring strategies.

***See Also:**

Air Quality Research:	Atmospheric Processes - **AR04**
Air Quality Research:	Sources/Inventories - **AR08 - AR10**
Air Quality Research:	Control and Remedial Technology - **AR12 - AR13 - AR14**
Water Quality Research:	Industrial Wastewater Treatment - **WA01 - WA02 - WA03 - WA04 - WA05**
Liquid and Solid Waste Research:	Waste Handling - **LS02 - LS03 - LS04**
Liquid and Solid Waste Research:	Waste Reduction - **LS05 - LS06 - LS07 - LS08**
Liquid and Solid Waste Research:	Landfill Technology - **LS09**

SOCIO-ECONOMIC RESEARCH: EVALUATION TOOLS AND APPLICATION

ISSUE: SE03

Development and application of procedures and methods to evaluate policies, programs and projects

Type of Research Needed:*

- Conduct benefit-cost analyses of specific programs, projects or activities.
- Application of Linear Programming Techniques to identify cost-effective abatement strategies.
- Determination of polluters' responses and behaviour under different regulatory regimes.
- Empirical design and testing of economic incentive policy instruments such as effluent charges or emission rights schemes.
- Compare non-economic evaluation techniques with benefit-cost analysis. Will such methods as the Judgemental Impact Matrix, forms of social impact assessment, risk assessments or net energy analysis yield the same conclusions as benefit-cost analysis given the same input data?
- Develop criteria for evaluating and making decisions concerning conservation and/or enhancement of productive capability, environmental quality, and renewable resources accruing over extremely long periods of time in contrast to conventional approaches to discounting future benefits.

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*See Also

Air Quality Research:	Risk Management/Criteria Development - AR07
Water Quality Research:	Industrial Wastewater Treatment - WA05
Water Quality Research:	Municipal Wastewater Treatment - WA08
Water Quality Research:	Statistical Significance in Contaminant Sampling - WA26
Liquid and Solid Waste Research:	Waste Reduction - LS05 - LS06 - LS07 - LS08

SOCIO-ECONOMIC RESEARCH: ENVIRONMENTAL PROTECTION INDUSTRY

ISSUE: SE04

Assessment of the characteristics, structure and performance of environmental protection related industries and businesses

Type of Research Needed:*

- Estimation of price elasticities of demand for secondary materials.
- Determinants of innovation in pollution abatement/ resource recovery technology.
- Determination of the economic dimensions, structure and performance of firms and industries which manufacture and sell pollution control equipment and supplies or which supply environmental protection services.
- Development of environmental auditing procedures.
- Assessment of the economic implications of the regulation of biotech applications.

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*See Also

Air Quality Research:	Control and Remedial Technology - AR12
Liquid and Solid Waste Research:	Waste Reduction - LS07 - LS08

SOCIO-ECONOMIC RESEARCH: SOCIAL (NON-ECONOMIC) IMPLICATIONS

ISSUE: SE05

Social implications of environmental contaminants and their control

Type of Research Needed:

- Development of a more comprehensive understanding of the social and psychological impacts of individual and community exposure to environmental contaminants, particularly in terms of:

  . the identification of factors that determine such impacts and processes by which they are manifested; and

  . the development and evaluation of strategies for predicting, preventing and/or mitigating social and psychological impacts.

- Identification of factors which determine public perceptions of, and responses to, risks associated with environmental contaminants.

- Development and evaluation of approaches for communicating information about environmental hazards and risks to the public.

- Empirical evaluation of different approaches to consulting the public on environmental issues.

- Development of new approaches or methodologies for predicting the social impacts of changes (improvements or decrements) in environmental quality.

- Assess theoretical foundations of benefit cost analysis, propose alternative ethical paradigms and test with case studies.

SOCIO-ECONOMIC RESEARCH: ENVIRO-ECONOMIC MODELLING

ISSUE: SE06

Development and testing of forecasting simulation and optimization models

Type of Research Needed:*

- **Comparisons of statistical and economic techniques and models to forecast:**
  - **. control technology changes;**
  - **. contaminant discharges/emissions; and**
  - **. spills.**
- **Development of bio-economic models and software to simulate and evaluate the consequences of possible pollution scenarios.**
- **Development of models to analyze financial impacts of environmental requirements.**

***See Also**
Air Quality Research: Atmospheric Processes **- AR04 - AR06**

Ministry of the Environment / Ministère de l'Environnement
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Date Received / Date de réception	
Proposal No. / Proposition n°	
Research Area / Domaine de recherche	

FORM 02

Application For Research Funding

FORMULE 02

Demande de financement de projets de recherche

This form is to be completed by the applicant for the benefit of the Ministry of the Environment and is intended to provide a summary of the detailed proposal. The Form 02 summary is the description of the proposal that will be submitted to the Research Advisory Committee for their review along with the reviewers' recommendations for funding. Five copies and the original of all documents are required when submitting an unsolicited or solicited proposal for funding by grant or contract.

The detailed proposal should include a thorough review of the available literature to support the rationale and objectives. All submissions should include clearly stated objectives and a full description of proposed methods, a detailed cost breakdown, a discussion of the anticipated contribution to the field of environmental research, and an appended list of relevant publications and curriculum vitae. Information must also be provided for any specialists or co-investigators named.

Generally, proposals should not exceed 20 pages in length, exclusive of supplementary appendices. The closing dates for the receipt of unsolicited proposals are January 15 and June 15. If approved, funding is effective upon notification by the Ministry (generally in May and October respectively).

CONDITIONS OF AWARD OF GRANT OR CONTRACT

In the event that a grant or contract is awarded, the principal investigator and his/her institution or company agree to:

1. Provide the Research Advisory Committee, Ministry of the Environment, with a written final report (galley-proof) plus five copies on the work completed during the project year (s) and with copies of all reports or publications resulting from this project. This may include supporting operational documents and software copies.

   It is understood that release or publication of the final report is contingent on approval by the Ministry of the Environment.

2. Execute an agreement on the Ministry's standard form before funds can be advanced.

3. Provide a progress report every six months in addition to the final report.

4. Provide a statement of grant expenditures at the end of each fiscal year (March 31) to the Liaison Officer and the Research Management Office.

5. Present a paper at the annual Technology Transfer Conference, if requested.

6. Provide to the Liaison Officer at the end of each project year a list of capital equipment purchased with grant or contract monies.

7. Immediately notify the Liaison Officer of any change in the scope or nature of the work program, and return all grant funds to the Ministry not required to carry out the approved, revised program. Major changes in scope require prior approval and contract amendment.

8. Return to the Ministry all grant funds remaining at the completion of the project.

9. Return all capital equipment purchased with grant or contract monies at the completion of the project or alternatively, make some other suitable arrangement in writing with the Research Advisory Committee if the equipment will continue to be used to carry out related work.

10. Allocate no stipend or salary paid to a university Principal Investigator(s) from a grant.

11. Allow an Ontario Provincial Government Auditor access to the financial and/or project records either during or after its completion, if requested.

La présente formule, qui doit être remplie par le demandeur pour le ministère de l'Environnement, vise à résumer la proposition. La formule 02 résume la description de la proposition qui sera soumise à l'étude du Comité consultatif de la recherche, accompagnée des recommandations de financement faites par les examinateurs de la proposition. Cinq copies des documents de même que leurs originaux doivent accompagner la demande de financement, par subvention ou par contrat, de la proposition, sollicitée ou non.

La proposition doit comprendre une étude détaillée des ouvrages existants dans le domaine de recherche afin d'appuyer la justification et les objectifs du projet. De plus, la demande de subvention doit inclure la liste complète des objectifs poursuivis, la description détaillée des méthodes utilisées pour atteindre ces objectifs, la ventilation des coûts, l'examen de la contribution apportée par le projet à la recherche environnementale et, en annexe, le curriculum vitae de l'intéressé (ou des intéressés), fournissant la liste des publications. On doit également fournir des renseignements sur tous les spécialistes et chercheurs nommés dans la description du projet.

De façon générale, la proposition ne doit pas dépasser 20 pages, appendices non compris. Toute proposition non sollicitée doit parvenir au ministère pour le 15 janvier ou le 15 juin. S'il est approuvé, le financement entre en vigueur lorsque le ministère avise le chercheur ou l'organisme de sa décision (généralement en mai et octobre).

CONDITIONS D'ATTRIBUTION D'UNE SUBVENTION OU D'UN CONTRAT

En cas d'attribution d'une subvention ou d'un contrat, le chercheur principal de même que l'organisme auquel il appartient s'engagent à :

1. Présenter par écrit au Comité consultatif de la recherche du ministère de l'Environnement un rapport final (épreuves en placard) et cinq copies sur les travaux effectués au cours du projet, comprenant des exemplaires de tous les rapports et publications, y compris les documents auxiliaires d'exploitation et les logiciels, résultant du projet.

   Il est entendu que la diffusion ou la publication du rapport final dépend de l'approbation du ministère de l'Environnement.

2. Établir une entente sur le formulaire d'entente du ministère, avant d'avancer des fonds.

3. Présenter un compte rendu semestriel en plus du rapport final.

4. Faire vérifier et présenter, à la fin de l'exercice financier (31 mars), à l'agent de liaison et au Bureau de gestion de la recherche, un état des dépenses concernant la subvention.

5. Présenter, le cas échéant, une communication au congrès annuel sur le transfert des techniques.

6. Fournir à l'agent de liaison, tous les ans après le début du projet, la liste des biens d'équipement achetés grâce à la subvention, ou au contrat.

7. Aviser immédiatement l'agent de liaison de tout changement d'orientation des travaux et remettre au ministère toute partie de la subvention qui n'est pas nécessaire à la réalisation des nouveaux travaux. Les changements d'orientation importants doivent être préalablement approuvés, et les contrats modifiés.

8. Remettre au ministère la partie non utilisée de la subvention une fois le projet terminé.

9. Rendre tous les biens d'équipement achetés grâce à la subvention ou au contrat lorsque le projet est terminé, ou conclure une entente écrite appropriée avec le Comité consultatif de la recherche si ces biens doivent continuer à être utilisés pour des travaux connexes.

10. Ne pas utiliser une subvention pour verser des honoraires ou payer un salaire à un chercheur universitaire principal.

11. Permettre, le cas échéant, à un vérificateur du gouvernement de l'Ontario d'examiner les états financiers et les dossiers, pendant ou après le projet.

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Proposal No. Proposition n°	Project No Projet n°

Principal Investigator Chercheur principal

Affiliation Affiliation

Research Proposal Summary Résumé de la proposition de recherche

Research Area Domaine de recherche

Type of Funding applied for: Type de financement demandé :
☐ Grant Subvention ☐ Contract Contrat ☐ Unsolicited Proposition non sollicitée ☐ Solicited Proposition sollicitée

Title of Proposed Research
Titre de la recherche

Short Title Titre abrégé

% of Principal Investigator's Time (Allocated to the Project)
Pourcentage de son temps qu'alloue le chercheur au projet _____ %

Principal Investigator's Title Titre du chercheur principal

Address Adresse

City/Town Ville | Province Province | Postal Code Code postal | Tel. No. N° de téléphone

Co-Investigator(s) Autre(s) chercheur(s)
1.

Affiliation Affiliation

2.

Affiliation Affiliation

BUDGET BUDGET	1st Year 1re année	2nd Year 2e année	3rd Year 3e année	TOTAL TOTAL
Salaries and Benefits Salaires et avantages sociaux				
Travel Déplacements				
Supplies and Equipment Matériel et équipement				
Overhead/Indirect Expenses (contractors only) Frais généraux et indirects (entreprise)				
Services (e.g. Computer Time) Services (p. ex. temps d'ordinateur)				
Other (specify) Autres (préciser)				
TOTAL TOTAL				
Total No. of Mandays Nombre total de jours de main-d'oeuvre				

Current or Previous Research Funding Financement de la recherche
Has this proposal or similar to it been submitted elsewhere for funding? Cette proposition, ou une semblable, a-t-elle fait l'objet d'une demande de financement auprès d'un autre organisme/ministère ?

☐ Yes Oui If yes, where?
☐ No Non Dans l'affirmative, auprès de qui? _____

Has it been accepted? ☐ Yes Oui ☐ No Non If yes, total approved funds _____ No. of Years _____
A-t-elle été acceptée? Dans l'affirmative, montant du financement total approuvé Nombre d'années

It is agreed that the general conditions as outlined in the Guideline for Proposal Submission apply to any grant or contract pursuant to this application and are hereby accepted by the applicant and the applicant's employing institution or company. Il est convenu que les conditions générales énumérées dans les Directives régissant la présentation des propositions s'appliquent à toute subvention ou contrat faisant l'objet de la présente demande et que le demandeur et son employeur acceptent ces conditions par la présente.

University Université

Dean, Head or Chairman Doyen, directeur ou président

Name Nom

Signature | Tel. No. N° de téléphone | Date

Financial Administrator Administrateur financier

Name Nom

Signature | Tel. No. N° de téléphone | Date

Director of Research Administration Directeur administratif de la recherche

Name Nom

Signature | Tel. No. N° de téléphone | Date

Principal Investigator Chercheur principal

Name Nom

Signature | Tel. No. N° de téléphone | Date

Contractor Entreprise

President or Principal Président ou directeur général

Name Nom

Signature | Tel. No. N° de téléphone | Date

Financial Administrator Administrateur financier

Name Nom

Signature | Tel. No. N° de téléphone | Date

Principal Investigator Chercheur principal

Name Nom

Signature | Tel. No. N° de téléphone | Date

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Proposal No Proposition n°	Project No Projet n°

Principal Investigator Chercheur principal	Affiliation Affiliation

1. Abstract (For Full Study) Résumé (de l'étude)

2. Objective(s) Objectif(s)

3. Milestone Definition and Schedule (For Full Study) Définition et calendrier des étapes (de l'étude)

Milestone No. Étape n°	Description Description	Anticipated Date of Completion Date prévue de la fin de l'étape

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Principal Investigator Chercheur principal	Affiliation Affiliation

4. Study Description Description de l'étude

Year 1 of Study 1re année de l'étude

Description Description

Anticipated Results Résultats prévus

Year 2 of Study 2e année de l'étude

Description Description

Anticipated Results Résultats prévus

Year 3 of Study 3e année de l'étude

Description Description

Anticipated Results Résultats prévus

Ontario

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Proposal No. Proposition n°	Project No. Projet n°

Principal Investigator Chercheur principal	Affiliation Affiliation

5. Relevance and Potential for Application Pertinence du projet et possibilités d'applications

What will this project contribute to the Ministry of the Environment's research needs?
Comment le projet répondra-t-il aux besoins en recherche du ministère de l'Environnement?

Describe potential for implementation of results, potential users and time frame for application of results by users.
Décrivez les applications possibles des résultats du projet, indiquez les usagers éventuels et fournissez le calendrier de ces applications.

Potential Marketability – Please describe if applicable
Possibilités de commercialisation – Donnez-en une description le cas échéant.